THURSDAY, FEBRUARY 16, 1882

HYPOTHETICAL HIGH TIDES

IN his interesting lecture entitled "A Glimpse through the Corridors of Time," recently published in NATURE, Prof. Ball, accepting Mr. George H. Darwin's view—that the moon was once part of the earth's mass, and after separation long revolved much nearer to us than now—estimates that when 40,000 miles distant she produced tides 216 times greater than the present, and advances the theory that these high tides have been the most powerful agents in producing changes on the earth's surface. He further presents this theory to geologists as a solution of some of their most difficult problems.

All this is exceedingly interesting if true. There can be no question that a tide of six hundred feet sweeping over all shores and lowlands twice a day would be a most powerful destructive and creative engine; and it may be conceded at once that its potency in remodelling the earth's surface would far surpass any agent of change now in action. Hence we may fairly infer that if such tides had prevailed in former times they should have left behind them universal and indisputable evidence of their existence.

Having studied with some care the geological record in places where it is as nearly complete as anywhere, I must say that I fail to find there any traces of the action of these stupendous tides pictured to the imagination by Prof. Ball. On the contrary the whole of that record, from the Archæan to the present time, offers evidence opposed to such a theory as he proposes.

Of what took place before the *Laurentian* strata were deposited we can gain no knowledge from the rocks, because these are the oldest known. We can only say that they are aqueous sediments of which the materials were derived from pre-existent land. Though much metamorphosed they are plainly the prototypes of the sandstones, shales, and limestones of later formations, and, we may fairly conclude, were deposited under like conditions. In the granites of the Laurentian we apparently have representatives of the coarser sediments formed along shores; the slates are the clays of ancient times, the wash of the land deposited in quiet waters off shore, while the marbles—which in some places form a considerable portion of the Laurentian series—are undoubtedly organic sediments that accumulated in quiet water, deep or shallow, by the slow processes of growth and decay of animal structures. Graphite, the product of plant life—probably fucoidal—exists in large quantities in the Laurentian rocks, and they contain enormous beds of iron ore which must have been accumulated by the aid of organic matter. Hence we may say that in the Laurentian age life was abundant, and much of this was littoral life, and that the vital unites with the physical in opposition to the high tide theory.

The *Huronian* series consists mostly of slates, quartzites (sometimes ripple-marked), and beds of iron ore, all shore and shallow water deposits speaking of quiet times and no high tides.

The *Cambrian* rocks are but imperfectly shown on the eastern side of the North American continent, and we will not stop to inquire minutely into the circumstances of their deposition. We may say, however, in passing, that they contain no really coarse material, and are all, so far as is known, the deposits of quiet waters.

In the *Lower Silurian* series, which is here remarkably complete, we have a record that tells with great clearnes the physical as well as the vital history of the continent in that age.

The *Potsdam Sandstone*, the base of our Silurian, is an old beach spread over large areas of pre-existent land by a slow and quiet subsidence, and the invasion of the sea. The Laurentian highlands, the Adirondachs, the Archean area south of Lake Superior, formed the shores of this sea; and the Ozark Mountains, the nucleus of the Black Hills, &c., were islands in this sea, each with its shore line. The old Potsdam beach is now exposed, and has been examined in hundreds of localities along a line of a thousand miles or more, and there the ancient sea margin can be followed as easily and certainly as we can now meander the line of the Atlantic coast. We everywhere find the history of the old beach written with unquestionable accuracy and in great detail. The strata are frequently ripple-marked and sun-cracked, their surfaces are covered with the interlacing casts of seaweeds, the sand is bored in every direction by annelids, and is full of the fragmentary or complete shells of the beach-loving linguias. This record not only includes no traces of extraordinary high tides, but is full of positive evidence that in the beginning of the Silurian age no tides much higher than at present swept the Atlantic coast of North America.

Above the Potsdam sandstone is spread a great sheet of organic material, the Trenton limestone group, in places a thousand feet thick, the deposits of quiet waters, and composed almost entirely of the hard parts of animals which inhabited them. As we approach the old shores these limestones become more earthy, and in places they abut directly against Laurentian cliffs, which supplied so little mechanical material as to form but a trifling percentage of the deposit made. Here we are on the old shore line, and are surrounded with evidence of the slow and quiet accumulation of material, and the entire absence of any indication of tidal action greater than that of the present day.

The same phenomena teach the same lesson in the records of the Upper Silurian, Devonian, and later geological ages. In the Devonian rocks we have another witness against extraordinarily high tides, for here are coral reefs rivalling those now forming in the tropical seas. Unless the reef-building polyps of the Devonian age were altogether different in habit from those now living, these coral reefs must have been formed in water less than two hundred feet in depth. Here high tides would have wrought the rapid destruction of the whole race of reef-building animals, at the ebb exposing them to the air for hours, and at the flood burying them too deeply for their continued existence. Nearly the same thing is taught by many of our great limestone beds. They are largely made up of mollusks, corals, &c., which inhabit a littoral zone, and it is evident that a tide hundreds of feet in height, sweeping to and fro over that zone, would have rendered it uninhabitable by them.

The sea-weeds now living in our oceans, chiefly occupy

the immediate shore, and most of them grow in a depth of water not exceeding forty feet. It is easy to see that if the present oceans were affected by a movement similar to that described by Prof. Ball, the zone of seaweeds would be the scene of the greatest mechanical violence, and they would be alternately left to dry in the sun, or be torn with irresistible force from their anchorage, and scattered over the land washed by the flood tide. But on every old beach, of which we find so many in the geological series, the casts of the fronds and stems of seaweeds are as plainly discernible as on our present shores. Indeed we may say that of the thousand forms of animal and vegetable life which have their home along the shores of continents, the seaweeds, the boring annelids, the lingulas, the oysters, the barnacles, in short the vast majority of mollusks and all the shore-loving fishes and crustaceans, none could possibly have existed while tides such as have been described prevailed; for that which is now their chosen habitat and the zone of greatest vital activity on the globe, would have been a scene of constant and terrible destruction.

It may also be said that if, as we suppose, the precipitation of ocean waters took place before the corrugations of the earth's surface had assumed any considerable magnitude, and it was nearly or quite covered with water, tidal waves five hundred or more feet in height sweeping over the earth in rapid succession would have worn away the emerging land as fast as it appeared, would have prevented the formation of continents, and have precluded the existence of land animals or plants. And farther, since marine vegetation is practically confined to shallow water, high tides would have rendered the growth of algæ impossible; and as they have supplied the pabulum for marine animal life, it follows that, with tides six hundred feet in height, our globe would have been a lifeless one.

For the reasons cited above, and others that might be given, we are compelled to conclude that the high tides which formed the subject of Prof. Ball's lecture have had no existence during the time covered by the geological record; and further, that since the beginning of that record the order of nature has been essentially what it is to-day. The testimony of the rocks on this subject is so full and conclusive, that it really leaves no room for discussion; and hence the astronomers have been in error in regard to the genesis of the moon, and she never formed a portion of the earth's mass, or the separation took place at a period so remote that she had receded to nearly her present distance before the dawn of life on the earth.

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EASY STAR LESSONS

Easy Star Lessons. By Richard A. Proctor. (London: Chatto and Windus, 1881.)

WE have been repeatedly struck by the comparative (it might have been said, more than comparative) ignorance which prevails, even among educated people, as to the nomenclature and position of the stars. There are many who would be grievously scandalised at the idea of not being able to call trees or flowers by their right names, but who seem very little concerned by having to admit a similar incompetency as to the beautiful luminaries of the skies. They would be indignant at the supposition that they did not know an oak from an ash, or could possibly mistake a cowslip for a primrose; but they have no hesitation to confess that they do not know the difference between the two dogs that have been for so many ages keeping guard in the heavens; and if possibly the pre-eminent brilliancy of Sirius, or the magnificent configuration of Orion, may have awakened enough of curiosity to ascertain what they are called, they would still be at an utter loss to discriminate between Capella and Arcturus, or to say in what constellation or at what time they are to look for the Pleiades, whose existence they can hardly ignore. It is not easy to account for such a degree of uninstructed heedlessness. One reason possibly may be, that the knowledge of natural objects which makes its way by such gentle and imperceptible approaches into the minds of intelligent children is acquired by day rather than by night, and that their rambles with parents and nurses in sunshine hours familiarise them insensibly with many things of which they would remain ignorant if they were visible only during their hours of rest. But, however we may try to explain it, so it is, that what was termed in a previous generation the "diffusion of useful knowledge," seems not to have included a popular acquaintance with the sky, and that the maps which were published under that title and to promote that object have been much more serviceable to the express student of astronomy than to educated society in general. Whether such a state of ignorance or *insouciance* may be equally prevalent in other countries we never had an opportunity of ascertaining; but there can be no doubt of it among ourselves, and as little question can be made that it is a discredit to the professed intellectual progess of the age.

Nor can a plausible excuse be fabricated from the want of adequate and familiar help. We pity those indeed who were obliged in former days to gain—or toil after—such knowledge from "exercises" on the celestial globe. Exercises indeed they were, to no common extent, of attention and patience, when some poor child had first of all to learn that left did not mean left, but right, and that she must fancy herself inside the globe to rectify what was drawn all wrong on its outside. This disagreeable and circuitous road to knowledge had indeed its advantages in the solution of problems which are probably less understood in its absence by a subsequent generation; but it was very troublesome, not to say expensive in its machinery, and passed away, to be succeeded by planispheres and delineations of various kinds, and of easier attainment, any of which would have done much towards giving the requisite information, had they been used, or we may say cared for. There was help enough had the want of it been felt as it should have been. But now that astronomy is so decidedly in the ascendant, and takes rank among the prevailing tastes of the age, an opportunity is offered for a fresh attempt, with a fairer prospect of success; and we are glad to find that it has been laid hold of by an author whose name is a sufficient guarantee for his accurate knowledge both of the objects to which he would introduce us, and of the means of delineating them as naturally, and with as little derangement of position, as may be. For it is not every one that knows—though any one may readily convince himself by a trial with the rind of a halved orange—how great is the difficulty of exhibiting a hemisphere on a plane surface, or how much ingenuity is required in arranging a number of planes to